

Effects of Model Performances on Music Skill Acquisition and Overnight Memory Consolidation

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Abstract

This study was designed to investigate the extent to which the presentation of an auditory model prior to learning a novel melody affects performance during active practice and the overnight consolidation of procedural memory. During evening training sessions, 32 nonpianist musicians practiced a 13-note keyboard melody with their left (nondominant) hand in twelve 30-s practice intervals separated by 30-s rest intervals. Participants were instructed to play the sequence “as quickly, accurately, and evenly as possible.” Approximately half the participants, prior to the first practice interval, listened to 10 repetitions of the target melody played at 552 tones per minute (half note = 138). All participants were tested on the target melody the following morning, approximately 12 hr after training, in three 30-s blocks separated by 30-s rest intervals. Performance was measured in terms of the mean number of correct key presses per 30-s block (CKP/B). Consistent with previous research, participants made considerable improvements in CKP/B during the evening training sessions and between the end of training and the morning test sessions. Learners who listened to the model made significantly larger gains in performance during training and between the end of training and test than did those who did not hear the model.

Keywords

skill learning, models, memory consolidation

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Dedicated musicians typically spend many hours each day refining skills and learning new repertoire, performing sequences of tasks that are intended to yield improvements in strength, facility, fluency, consistency, and speed (Krampe & Ericsson, 1996). It has long been understood that repeated practice over time may improve these dimensions of music performance (e.g., Maynard, 2006), although the precise mechanisms underlying the mastery of refined skills and the neural representations of the procedural memories associated with behavioral improvements are only beginning to be elucidated more clearly (Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005; Cherbuin & Brinkman, 2005; Classen & Cohen, 2003; Classen, Liepert, Wise, Hallett, & Cohen, 1998).

Effective practice requires the formulation of clear performance goals on the part of the learner (Austin & Berg, 2006; Barry & McArthur, 1994; Bartolome, 2009; Chaffin & Imreh, 2001; Coffman, 1990; Duke, Simmons, & Cash, 2009; Hallam, 1997). In order for learners to bring about productive changes in what they do during independent practice, they must envision what they are attempting to accomplish in the short and long term and must recognize the differences between their current behavior and the goals to which they aspire. Live and recorded performance models serve an obvious function in this regard, as models provide vivid representations of goals that learners are working to achieve, thus influencing learners' focus of attention and motivation.

The effects of models on skill learning have been studied in a number of different domains of human endeavor (e.g., Blandin, Lhuisset, & Proteau, 1999; Couzijn, 1999; Lai, Shea, Bruechert, & Little, 2002; Maslovat, Hodges, Krigolson, & Handy, 2010; Rohbanfard & Proteau, 2011a, 2011b; Shea, Wulf, Park, & Gaunt, 2001; Wulf, Shea, & Lewthwaite, 2010), including music. The work in music, to date, has investigated models' effects by comparing learners who did and did not have access to recorded models, measuring performance quality at the end of a given practice period (Frewen, 2010; Hewitt, 2001; Montemayor & Moss, 2009; Morrison, 2002; Morrison, Montemayor, & Wiltshire, 2004; Rosenthal, 1984; Rosenthal, Wilson, Evans, & Greenwalt, 1988; Theiler & Lippman, 1995). But the benefits of performance models have yet to be convincingly demonstrated in music research, as the findings obtained in music have been quite mixed, primarily as a result of vast differences in participant populations, research protocols, and durations of treatment. Furthermore, few investigations in music reveal the effects of performance models on *learning in the near-term*; that is, how model performances affect the development of skills immediately following the presentation of a model.

It is now well known that the refinement and enhancement of skills may continue long after active practice has ended, absent the conscious attention of the learner. During the hours following initial practice of novel skills (e.g., brief movement sequences that include no auditory processing demands), labile procedural memories are stabilized, rendering them less vulnerable to interference and forgetting, through the process of memory consolidation (Brashers-Krug, Shadmehr, & Bizzi, 1996; Walker, 2005; Walker, Brakefield, Hobson, & Stickgold, 2003a). During overnight sleep, memories encoded during the waking day undergo further modification and

refinement, often resulting in observable enhancements in performance the following day (Brashers-Krug et al., 1996; Korman, Raz, Flash, & Karni, 2003; Walker, Brakefield, Hobson, & Stickgold, 2003).

More recently, memory consolidation has been explored with nonmusicians and skilled musicians performing musical tasks, with similar results. Simmons and Duke (2006) first demonstrated that musicians learning brief melodies showed evidence of sleep-based enhancements in the accuracy of their performances. Subsequent investigations in music have further illuminated variables that influence the formation and refinement of skill memories following practice: interposing rest breaks during initial practice (Cash, 2009; Duke, Allen, Cash, & Simmons, 2009), practicing similar novel melodies in juxtaposition (Allen, 2012), and distributing practice across different intervals of time (Simmons, 2012).

In the current study, we investigated the effects of an auditory model on the development of speed and accuracy in the performance of a novel melody. Comparing data from learners who did and did not hear an auditory model prior to beginning practice, we considered the effects of the model on both the rate of learning during active practice and the extent of memory enhancement during overnight sleep.

Method

Participants were 32 right-handed undergraduate and graduate music majors enrolled in various degree programs in the Sarah and Ernest Butler School of Music at the University of Texas at Austin (12 females; age, $M = 22.81$; $SD = 4.27$).¹ All were woodwind or string players who had completed no more than four semesters of undergraduate class piano instruction and had taken no more than 2 years of private piano instruction. All participants were financially compensated for their participation. The study was approved by the institutional review board of the University of Texas at Austin.

Participants reported individually for two sessions scheduled approximately 12 hr apart, one in the evening between 8:00 p.m. and 10:00 p.m. and one the following morning between 8:00 a.m. and 10:00 a.m., following overnight sleep. In the evening training sessions, participants practiced a 13-note melody with their left (nondominant) hand on a digital piano, performing the melody using prescribed fingerings during twelve 30-s practice blocks separated by 30-s rest intervals. They were instructed to repeat the melody from beginning to end “as quickly and accurately as possible” throughout each 30-s block. In the morning test sessions, participants performed the melody as they had during training in three 30-s practice blocks separated by 30-s rest intervals.

The target melody (Figure 1) was adapted from a previous study (Simmons & Duke, 2006). Music notation and fingerings were visible on a computer screen positioned at the height of the keyboard’s music rack throughout both training and test sessions. Throughout the experimental procedures, participants wore high-quality headphones through which they heard the sound of the piano and the model performance.



Figure 1. Target melody (numbers below notation indicate left hand fingerings; 1 = thumb).

Experimental conditions were assigned randomly to participants. Instructions describing the experimental task were read to participants by a test proctor. The instructions for the control group ($n = 15$) included the following statement: “Your goal is to play the melody as quickly, accurately, and evenly as possible.” The proctor read the following text to participants in the model group ($n = 17$):

Before we begin, I am going to play a recording of this melody for you, and I would like your ultimate goal to be to match as closely as possible the speed, accuracy, and evenness of that model. Again, your goal is to play the melody as quickly, accurately, and evenly as possible; in other words, work toward performing as close to the recorded model as you can. I will remind you of that throughout the course of your practice. Do you have any questions?

Participants in the model group then listened to 10 repetitions of the target melody played at 552 tones per minute (half note = 138), considerably faster than we believed was possible for participants to achieve in a single practice session. The model tempo was 50% faster than the fastest performance speed obtained by the end of training by participants in studies by Allen (2012) and Duke et al. (2009).²

Before participants began each evening training and morning test session, they rated their feelings of alertness using the Stanford Sleepiness Scale (Hoddes, Zarcone, Smythe, Philips, & Dement, 1973). They agreed to refrain from drugs, alcohol, and caffeine for 12 hr prior to and during the experiment, to get a full night’s sleep between evening and morning sessions, and to avoid practicing any instrument between the two sessions.

The Musical Instrument Digital Interface (MIDI) data for the piano performances were recorded on an Apple laptop computer using software written specifically for this experiment in Max/MSP. We measured performance of the melody in terms of the number of correct key presses per 30-s block (CKP/B). This procedure is identical to that used in previous studies with similar protocols (cf. Review of Literature), combining speed and accuracy in a single measure. In our statistical analyses, we compared the mean CKP/B for the first three blocks of training (TR 1-2-3), the last three blocks of training (TR 10-11-12), and the three blocks of the morning test (T 1-2-3).

Results

Participants reported an average of 7.09 hr ($SD = 1.13$) of overnight sleep prior to training and 6.94 hr ($SD = 0.73$) of sleep prior to test. There were no systematic

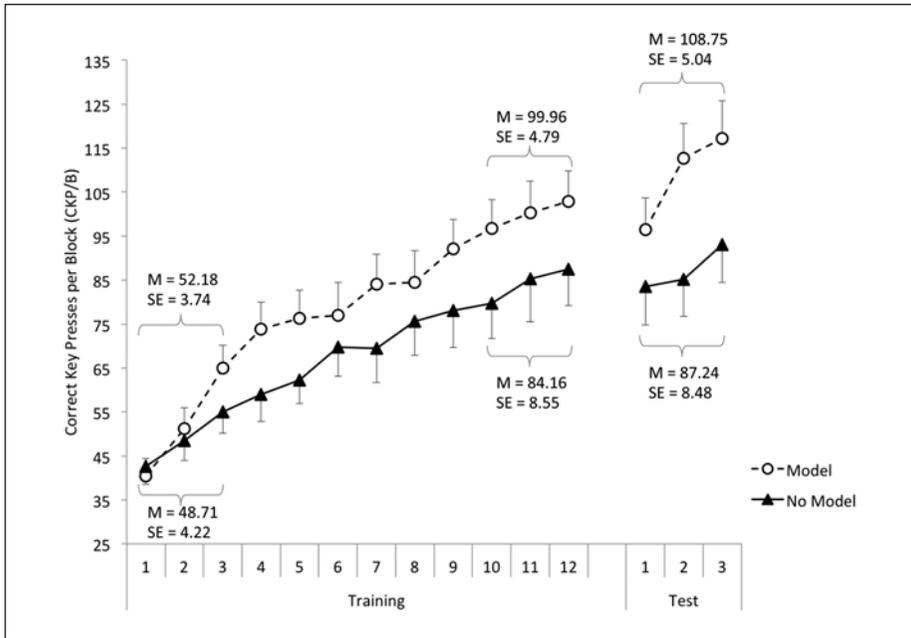


Figure 2. Performance, as measured by the number of correct key presses per block (CKP/B) during training and test sessions. Error bars represent ± 1 SE.

differences between groups in terms of hours slept prior to training, $t(30) = 0.97, p = .34$, or prior to test, $t(30) = 0.69, p = .50$. We found no relationships between hours slept prior to training and the performance at the beginning of training, $r(30) = .11, p = .57$, or performance at the end of training, $r(30) = .23, p = .20$. We also found no relationship between performance improvements observed at test and hours slept in the preceding night, $r(30) = .17, p = .34$.

We compared participants' reports of alertness, collected using the Stanford Sleepiness Scale at the beginning of each session, and found no differences between the groups in terms of reported sleepiness ratings prior to training, $t(30) = 0.23, p = .82$, or prior to test, $t(30) = 0.27, p = .79$. We found no relationships between sleepiness ratings and performance at the start of training, $r(30) = .01, p = .94$, or performance at the end of training, $r(30) = -.13, p = .48$. Neither did we find a relationship between sleepiness ratings and performance improvements observed at test, $r(30) = .24, p = .18$.

Consistent with previous research, participants made significant performance improvements within evening training sessions as well as significant overnight gains. Using a 2×3 (Group \times Time Point) ANOVA with repeated measures, we compared CKP/B in group performances at three time points: the mean of TR 1-2-3, the mean of TR 10-11-12, and the mean of T 1-2-3 (see Figure 2). We found no significant differences between groups overall, $F(1, 30) = 3.19, p = .08$; significant differences between performances at the three time points, $F(2, 60) = 133.23, p < .001, \eta^2_p = .82$; and a significant Group \times Time Point interaction, $F(2, 60) = 4.22, p = .02, \eta^2_p = .12$. Post hoc

comparisons using Bonferroni's procedure revealed that the CKP/B mean at the end of training was significantly greater than the CKP/B mean at the start of training, $p < .001$, and that the mean at test was significantly greater than the CKP/B mean at the start of training, $p < .001$, and the CKP/B mean at the end of training, $p = .046$. Learners who listened to the model made larger gains in performance during training and between the end of training and test than did those who did not hear the model (see Figure 2).

The effect of the auditory model is revealed in the interaction, as the rates at which the groups improved were different across the course of the experiment. As shown in Figure 2, learners who heard the auditory model improved from a mean of 52.18 CKP/B at the beginning of training to 99.96 CKP/B at the end of training (+92%). Learners who did not hear the model performance improved from a mean of 48.71 CKP/B at the beginning of training to 84.16 CKP/B at the end of training (+73%). Following a night of sleep, learners who had heard the model improved from a mean of 99.96 CKP/B at the end of training to 108.75 CKP/B during the morning test (+9%). Learners who had not heard the model improved overnight from a mean of 84.16 CKP/B to 87.24 CKP/B at test (+4%).

Discussion

Our data demonstrate that hearing an auditory model prior to practice led experienced musicians to reach performance levels that were significantly greater than those attained by musicians who had not heard a model. Both groups of learners had been instructed to perform the target melody as quickly, accurately, and evenly as possible, but the musicians who heard the model outperformed the other participants throughout the course of evening training and at morning test.

The mechanisms that led to these group differences are as yet unclear and require considerable further study. Yet, the data from the current experiment suggest that in the practice of novel tasks, there are short-term advantages to be gained by presenting learners with models that define challenging performance goals. Whether this leads to performance advantages as a result of increasing learner motivation or as a result of some other mechanism remains in question.

We had observed in previous experiments using this protocol that musician participants often determine independently what they consider an appropriate tempo for a given test melody. Such musical decision making is not uncommon, of course. Musical convention and the structure of common-practice music suggest ranges of tempos within which melodies may be performed and "sound right."

Musicians who begin practicing test melodies without hearing a model performance seem to determine implicitly and over the course of practice a target performance tempo that seems to them appropriate. Once they have settled on this tempo, they may hesitate to push themselves to perform faster, effectively ignoring the experimenter's instruction to play as quickly as possible.

Our observations here and in previous studies suggest that experienced musicians adopt the general principle of practicing only as quickly as they can perform without

error. In the implicit competition between speed and accuracy, accuracy typically prevails. Thus, experienced musicians may underestimate the speeds at which they are capable of performing during practice and, in an effort to obviate note errors, may limit the efficiency of their practice efforts. This speculation will require a great deal more experimentation to verify or refute.

The extent to which the superior performance of the experimental group in the current investigation may be attributed to increased motivation or to differences in cognitive and motor function as a result of having heard the model is impossible to determine from our data. It may be that the presentation of the model created a challenging goal that musicians then invested effort to achieve, and that the goal set by the model elicited greater effort among musicians in the experimental group than did the more modest tempo goals determined independently by musicians in the control group.

It also is possible that hearing the model created an auditory template that primed the motor system prior to the start of active practice (Buccino & Riggio, 2006; Lahav, Saltzman, & Schlaug, 2007). It is known that even in the absence of physical engagement, neurons in the motor system are activated when individuals listen to a newly learned melody and when they observe motor behavior with which they are familiar, even when familiarity is acquired in a single training session (Bertenthal, Longo, & Kosobud, 2006; Lahav, Boulanger, Schlaug, & Saltzman, 2005). Recall that our participants were highly skilled musicians with some training in piano playing. As a result of their familiarity with the task of playing a keyboard, hearing the model in fact may have engaged the motor system prior to active practice in ways that advantaged the acquisition of the target melody.

We also observed improvements between the end of evening training and test that were comparable to improvements observed in other investigations of this type (Allen, 2012; Duke, Allen, et al., 2009; Simmons & Duke, 2006); however, the overnight improvement in the control group in the current study was well below what we have observed previously. This result is difficult to explain. Other investigations have shown overnight improvements in CKP/B on the order of 10% to 15%. The overnight improvement in the experimental group in the current study seems consistent with those earlier observations. The small improvement in the control group does not. We can find no relationship between any of the participants' demographic variables, their practice behavior, or their sleep and alertness reports that would explain their lack of substantial improvement overnight.

It is certainly too soon to speculate whether the effects that we observed in a controlled experiment would be discernible in the day-to-day practicing of musicians, either novice or expert. Our practice protocol and assessment procedure permitted us to detect differences in the rates of learning and in the extent of consolidation-based enhancements that may not be readily observable in musicians' typical practice, especially in practice sessions that involve the rehearsal of multiple tasks.

Yet, although the data in the current experiment were obtained from adult musicians practicing in a way that is unlike typical music practice, the results seem relevant to music learning across levels of experience and training. Of course, the notion of auditory models advantaging learners is not new to music teachers, among whom it

seems well accepted that listening to and observing models are useful contributors to learning music skills. But the underlying cognitive and neural mechanisms through which models may advantage learners have yet to be explained, not only in music but in other domains of human endeavor as well. Our data demonstrate that hearing a model performance that is performed at a speed beyond what may be attained in a single practice session led experienced musicians to accomplish more during active practice and to benefit more from overnight memory consolidation than did musicians who did not hear a model. These results raise as many questions as they answer, and they suggest tantalizing possibilities for music learning that will require considerably more study to realize.

Declaration of Conflicting Interests

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Notes

1. Data were collected from 35 participants. Two individuals did not complete the experiment for reasons unrelated to the study. A third participant was excluded from the analyses because her keyboard skills far exceeded those of the remaining participants; her CKP/B in the first three blocks of training were greater than 5 standard deviations above the mean for the remainder of the participants in her group.
2. We set the tempo of the model to be 50% faster than the fastest tempo obtained by any participant at the end of training in the two previous investigations that used this melody. In Allen's (2012) study the mean tempo obtained by the end of training was approximately 258 tones per minute (half note = 56); the fastest tempo obtained by an individual participant was 369 tones per minute (half note = 92). Duke et al. (2009) reported that the mean tempo obtained by the end of training was approximately 196 tones per minute (half note = 49); the fastest tempo obtained by an individual performer was 305 tones per minute (half note = 76).

References

- Allen, S. E. (2012). Memory stabilization and enhancement following music practice. *Psychology of Music, 41*, 779–793.
- Austin, J. R., & Berg, M. H. (2006). Exploring music practice among sixth-grade band and orchestra students. *Psychology of Music, 34*, 535–558. doi:10.1177/0305735606067170
- Barry, N. H., & McArthur, V. (1994). Teaching practice strategies in the music studio: A survey of applied music teachers. *Psychology of Music, 22*, 44–55. doi:10.1177/0305735694221004
- Bartolome, S. J. (2009). Naturally emerging self-regulated practice behaviors among highly successful beginning recorder students. *Research Studies in Music Education, 31*(1), 37–51. doi:10.1177/1321103x09103629
- Bertenthal, B. I., Longo, M. R., & Kosobud, A. (2006). Imitative response tendencies following observation of intransitive actions. *Journal of Experimental Psychology: Human Perception and Performance, 32*, 210–225. doi:10.1037/0096-1523.32.2.210

- Blandin, Y., Lhuisset, L., & Proteau, L. (1999). Cognitive processes underlying observational learning of motor skills. *Quarterly Journal of Experimental Psychology A: Human Experimental Psychology*, *52A*, 957–979. doi:10.1080/027249899390882
- Brashers-Krug, T., Shadmehr, R., & Bizzi, E. (1996). Consolidation in human motor memory. *Nature*, *382*(6588), 252–255. doi:10.1038/382252a0
- Buccino, G., & Riggio, L. (2006). The role of the mirror neuron system in motor learning. *Kinesiology*, *38*, 5–15.
- Cash, C. D. (2009). Effects of early and late rest intervals on performance and overnight consolidation of a keyboard sequence. *Journal of Research in Music Education*, *57*, 252–266. doi:10.1177/0022429409343470
- Chaffin, R., & Imreh, G. (2001). A comparison of practice and self-report as sources of information about the goals of expert practice. *Psychology of Music*, *29*, 39–69. doi:10.1177/0305735601291004
- Charness, N., Tuffiash, M., Krampe, R., Reingold, E., & Vasyukova, E. (2005). The role of deliberate practice in chess expertise. *Applied Cognitive Psychology*, *19*, 151–165. doi:10.1002/acp.1106
- Cherbuin, N., & Brinkman, C. (2005). Practice makes two hemispheres almost perfect. *Cognitive Brain Research*, *24*, 413–422. doi:10.1016/j.cogbrainres.2005.02.010
- Classen, J., & Cohen, L. G. (2003). Practice-induced plasticity in the human motor cortex. In S. Boniface & U. Ziemann (Eds.), *Plasticity in the human nervous system: Investigation with transcranial magnetic stimulation* (pp. 90–106). Cambridge, England: Cambridge University Press.
- Classen, J., Liepert, J., Wise, S., Hallett, M., & Cohen, L. G. (1998). Rapid plasticity of human cortical movement representation induced by practice. *Journal of Neurophysiology*, *79*, 1117–1123.
- Coffman, D. D. (1990). Effects of mental practice, physical practice, and knowledge of results on piano performance. *Journal of Research in Music Education*, *38*, 187–196. doi:10.2307/3345182
- Couzijn, M. (1999). Learning to write by observation of writing and reading processes: Effects on learning and transfer. *Learning and Instruction*, *9*, 109–142. doi:10.1016/S0959-4752(98)00040-1
- Duke, R. A., Allen, S. E., Cash, C. D., & Simmons, A. L. (2009). Effects of early and late rest breaks during training on overnight memory consolidation of a keyboard melody. *Annals of the New York Academy of Sciences*, *1169*, 169–172. doi:NYAS04795 [pii] 10.1111/j.1749-6632.2009.04795.x
- Duke, R. A., Simmons, A. L., & Cash, C. D. (2009). It's not how much, it's how: Characteristics of practice behavior and the retention of performance skills. *Journal of Research in Music Education*, *56*, 310–321. doi:10.1177/0022429408328851
- Frewen, K. G. (2010). Effects of familiarity with a melody prior to instruction on children's piano performance accuracy. *Journal of Research in Music Education*, *57*, 320–333. doi:10.1177/0022429409351178
- Hallam, S. (1997). Approaches to instrumental music practice of experts and novices. In H. Jorgensen & A. C. Lehmann (Eds.), *Does practice make perfect? Current theory and research on instrumental music practice*. Oslo, Norway: Norges Musisikkhøgskole.
- Hewitt, M. P. (2001). The effects of modeling, self-evaluation, and self-listening on junior high instrumentalists' music performance and practice attitude. *Journal of Research in Music Education*, *49*, 307–322. doi:10.2307/3345614
- Hoddes, E., Zarcone, V., Smythe, H., Philips, R., & Dement, W. C. (1973). Quantification of sleepiness: A new approach. *Psychophysiology*, *10*, 431–436. doi:10.1111/j.1469-8986.1973.tb00801.x

- Korman, M., Raz, N., Flash, T., & Karni, A. (2003). Multiple shifts in the representation of a motor sequence during the acquisition of skilled performance. *Proceedings of the National Academy of Sciences*, *100*, 12492–12497. doi:10.1073/pnas.2035019100
- Krampe, R. T., & Ericsson, K. (1996). Maintaining excellence: Deliberate practice and elite performance in young and older pianists. *Journal of Experimental Psychology: General*, *125*, 331–359. doi:10.1037/0033-295X.100.3.363
- Lahav, A., Boulanger, A., Schlaug, G., & Saltzman, E. (2005). The power of listening: Auditory-Motor interactions in musical training. *Annals of the New York Academy of Sciences*, *1060*, 189–194. doi:10.1196/annals.1360.042
- Lahav, A., Saltzman, E., & Schlaug, G. (2007). Action representation of sound: Audiomotor recognition network while listening to newly acquired actions. *Journal of Neuroscience*, *27*, 308–314. doi:10.1523/JNEUROSCI.4822-06.2007
- Lai, Q., Shea, C. H., Bruechert, L., & Little, M. (2002). Auditory model enhances relative-timing learning. *Journal of Motor Behavior*, *34*, 299–307. doi:10.1080/00222890209601948
- Maslovat, D., Hodges, N. J., Krigolson, O. E., & Handy, T. C. (2010). Observational practice benefits are limited to perceptual improvements in the acquisition of a novel coordination skill. *Experimental Brain Research*, *204*, 119–130. doi:10.1007/s00221-010-2302-7
- Maynard, L. (2006). The role of repetition in the practice sessions of artist-teachers and their students. *Bulletin of the Council for Research in Music Education*, *167*, 61–72.
- Montemayor, M., & Moss, E. A. (2009). Effects of recorded models on novice teachers' rehearsal verbalizations, evaluations, and conducting. *Journal of Research in Music Education*, *57*, 236–251. doi:10.1177/0022429409343183
- Morrison, S. J. (2002). The use of recorded models in the instrumental rehearsal. *Update: Applications of Research in Music Education*, *20*, 21–26. doi:10.1177/875512330202000206
- Morrison, S. J., Montemayor, M., & Wiltshire, E. S. (2004). The effect of a recorded model on band students' performance self-evaluations, achievement, and attitude. *Journal of Research in Music Education*, *52*, 116–129. doi:10.2307/3345434
- Rohbanfard, H., & Proteau, L. (2011a). Effects of the model's handedness and observer's viewpoint on observational learning. *Experimental Brain Research*, *214*, 567–576. doi:10.1007/s00221-011-2856-z
- Rohbanfard, H., & Proteau, L. (2011b). Learning through observation: A combination of expert and novice models favors learning. *Experimental Brain Research*, *215*, 183–197. doi:10.1007/s00221-011-2882-x
- Rosenthal, R. K. (1984). The relative effects of guided model, model only, guide only, and practice only treatments on the accuracy of advanced instrumentalists' musical performance. *Journal of Research in Music Education*, *32*, 265–273. doi:10.2307/3344924
- Rosenthal, R. K., Wilson, M., Evans, M., & Greenwalt, L. (1988). Effects of different practice conditions on advanced instrumentalists' performance accuracy. *Journal of Research in Music Education*, *36*, 250–257. doi:10.2307/3344877
- Shea, C. H., Wulf, G., Park, J.-H., & Gaunt, B. (2001). Effects of an auditory model on the learning of relative and absolute timing. *Journal of Motor Behavior*, *33*, 127–138. doi:10.1080/00222890109603145
- Simmons, A. L., & Duke, R. A. (2006). Effects of sleep on performance of a keyboard melody. *Journal of Research in Music Education*, *54*, 257–269. doi:10.1177/002242940605400308
- Simmons, A. L. (2012). Distributed practice and procedural memory consolidation in musicians' skill learning. *Journal of Research in Music Education*, *59*, 357–368. doi:10.1177/0022429411424798

- Theiler, A. M., & Lippman, L. G. (1995). Effects of mental practice and modeling on guitar and vocal performance. *Journal of General Psychology, 122*, 329–343. doi:10.1080/00221309.1995.9921245
- Walker, M. P. (2005). A refined model of sleep and the time course of memory formation. *Behavioral and Brain Sciences, 28*, 51–104. doi:10.1017/S0140525X05000026
- Walker, M. P., Brakefield, T., Hobson, J. A., & Stickgold, R. (2003). Dissociable stages of human memory consolidation and reconsolidation. *Nature, 425*(6958), 616–620. doi:10.1038/nature01930
- Wulf, G., Shea, C., & Lewthwaite, R. (2010). Motor skill learning and performance: A review of influential factors. *Medical Education, 44*, 75–84. doi:10.1111/j.1365-2923.2009.03421.x

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